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Update on continuous peripheral nerve blocks

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Continuous peripheral nerve block (cPNB) refers to the use of a percutaneously inserted catheter with its tip adjacent to a target peripheral nerve or plexus, through which local anaesthetic can be administered to enable a prolonged period of titratable perineural blockade. cPNB has an attractive safety and efficacy profile, and can be extremely useful for managing various types of pain. However, careful consideration should be given to patient and surgical factors, the expertise of the attending anaesthesiologist and systems available for follow-up after initiation of the cPNB.

Keywords: continuous peripheral nerve block, percutaneously inserted catheter

Introduction

The benefits of regional anaesthesia have been well documented.[1] However, one of the most significant limitations of this technique is the short duration of action compared to the period of clinically significant pain associated with many surgical procedures. Continuous peripheral nerve block (cPNB) refers to the use of a percutaneously inserted catheter with its tip adjacent to a target peripheral nerve or plexus, through which local anaesthetic can be administered to enable a prolonged period of titratable perineural blockade.

Indications

cPNB is indicated where peripheral nerve block will be beneficial for a longer duration than what can be covered by a single-shot peripheral nerve block (ssPNB).[2] Although the majority of literature on cPNB refers to perioperative analgesia, this technique has also been used for the management of various chronic pain syndromes, improved range of shoulder motion after manipulation for adhesive capsulitis, orthopaedic trauma, abdominal wall pain in pregnancy, palliative analgesia and to optimise perfusion in free flap surgery.[3-5] There is also a growing body of evidence for its use in children.[6]

Benefits of cPNB

When compared with alternatives, cPNB is an attractive option for postoperative analgesia.[2,4]

Comparison with systemic analgesia

The addition of cPNB to multimodal systemic analgesia decreases surgical stress response, pain scores and opioid-consumption, allows for earlier awakening from general anaesthesia and improves patient satisfaction.[7] Benefits extend into the prolonged postoperative period, with some studies showing significantly decreased pain, opioid requirements and sleep disturbances measurable a week postoperatively.[8] Perineural catheter techniques may decrease the incidence of chronic pain and associated psychological dysfunction up to a year postoperatively.[8,9] The use of adductor canal cPNB after knee arthroplasty, shortens the time to achieve flexion goals, improves analgesia, lowers supplemental analgesic requirements and can improve joint flexion up to six months postoperatively.[6-8] There is current interest in the possible role of regional anaesthesia in decreasing cancer recurrence, although robust evidence is still lacking.[7]

Advantages of cPNB over ssPNB

Compared with ssPNB, cPNB improves postoperative pain, decreases analgesic requirements, shortens time to discharge-readiness and improves patient satisfaction.[6,7,10] However, placing a single perineural catheter for surgical sites innervated by multiple nerves provides less than optimal results unless supplemented by systemic analgesia.[6] The addition of adjuvant drugs such as dexamethasone or dexmedetomidine to ssPNB may increase the duration of analgesia, but still not beyond 24 hours and ongoing concerns regarding neurotoxicity of these drugs have limited their use.[11] In general, the use of liposomal bupivacaine for ssPNB has yielded disappointing results, particularly in view of the cost differential of this formulation.[12] Placement of perineural catheters also gives the flexibility to use different local anaesthetics or different concentrations at various points in the patient's care based upon differing clinical requirements.

Comparison with neuraxial techniques

Compared with epidural analgesia, cPNB provide similar analgesia but with improved haemodynamic stability and avoidance of other severe complications associated with the former.[13] When compared with intrathecal morphine, similar analgesic effects are produced with lower supplemental opioid requirements and reduced incidence of pruritis.[6] However, in certain circumstances, the sympathetic blockade achieved by

neuraxial techniques may be desirable and not accomplished by peripheral blockade.[14]

Advantage over intra-articular catheters

cPNB provides superior analgesia compared with intra-articular catheters for knee and shoulder surgery.[15,16] In addition, there is a concern regarding local anaesthetic toxicity to chondrocytes with prolonged intra-articular infusion.[17]

Comparison with percutaneous peripheral nerve stimulation

There is growing interest in this modality as an alternative to cPNB for prolonged analgesia, with touted benefits being a decreased risk of peripheral nerve injury and infection, allowing for a potentially prolonged duration of use. Use of this technology is also not associated with motor and sensory deficits and may in the future become a more readily available option for analgesia.[12]

Ambulatory perineural infusion

Outpatient management improves quality of life by enabling convalescence in the comfort of the patient's own home, a lower risk of nosocomial infection and lower associated hospital costs.[18] However, pain and postoperative nausea and vomiting remain most common reasons for prolonged hospitalisation or unplanned readmission.[18] Research involving ambulatory cPNB has been prolific in recent years and emerging evidence suggests that this technique is safe and provides significant cost-saving opportunities in this setting.[19]

Table I: Complications of cPNB

Complication	Incidence*	Aetiology/Risk factors	Mitigation of risk
Ectopic tip location[23]	Case reports	Incorrect initial placement (catheter migration unlikely)	Catheter insertion < 5 cm beyond needle Initiate infusion under monitoring US-guided insertion LA test dose via catheter
LAST[24-26]	Rare	Intravascular injection LA accumulation with prolonged infusion	US-guided insertion (↓ risk intravascular injection) Limit concentration of infusion Caution in elderly or patients with comorbidities
Respiratory distress[20,27]	40% phrenic nerve palsy with cISB (0.1% respiratory failure)	Phrenic nerve block with initial block or accumulation of LA with prolonged infusion	Ultrasound-guided regional anaesthesia (UGRA) ↓ LA volume Phrenic nerve sparing blocks
Myotoxicity[28]	↑ risk with ophthalmic blocks and adductor canal catheters	Myotoxicity of LA ↑ risk with ↑ concentrations, prolonged duration and bupivacaine	Limit duration < 3 days Use lowest effective concentration Avoid bupivacaine
Catheter retention during withdrawal[4]	Case reports	Most reported with stimulating catheter and insertion depth > 5 cm	Catheter-over-needle† Limit insertion depth
Infection[4,5,29,30]	Inflammation: 3–4% Bacterial colonisation: 6–57% Clinically significant infection: 1% No reported cases of permanent injury	↑ risk with diabetes, obesity, ICU admission, absence of perioperative antibiotics, male gender ? ↑ risk with axillary, femoral and cISB ↑ duration of infusion	Strictly sterile insertion technique Limited evidence ↓ risk with subcutaneous tunnelling Limit duration (no maximum duration per se, but most studies suggest < 5 days)
Postoperative neurological symptoms[20,25,31]	0–1.4% cISB	Multifactorial (RA is not independent risk factor for PONS) risk with cPNB does not appear to be greater than ssPNB	
Major haematoma[4]	+++ Rare	Anticoagulation Hepatic/haematological comorbidity	
Fall risk[1,32,33]	0.3%	Continuous femoral or lumbar plexus block	Adductor canal block preserves quadriceps strength (yet to be shown to decrease fall risk)
Catheter failure[4]	0.5–26%	Inaccurate placement or dislodgement	US visualisation of catheter tip Secure catheter with tissue adhesive, adhesive dressings or suture
Hoarseness[27]	40% cISB	Recurrent laryngeal nerve palsy	Low volumes, distil blocks
Leakage at catheter site[34]	1.8–3.7%	May cause contamination of surgical site	CON system Tissue adhesive
MRI heating risk		Catheters containing coils to prevent kinking	Check manufacturer specifications prior to MRI
Patient distress regarding insensate limb			Careful patient counselling and written information sheets

LA – local anaesthetic, US – ultrasound, LAST – local anaesthetic systemic toxicity, CON – catheter-over-needle, cISB – continuous interscalene block
* Wide variation in reported incidence likely due to heterogeneous equipment, techniques, anatomic locations and infusion protocols
† Intuitively, CON would appear to have lower risk of retention; however, data are lacking.

Complications

While a cPNB has definite advantages, it is more difficult to insert than an ssPNB and require more intensive post-procedure follow-up.[2] Current evidence suggests that the use of cPNB does *not* increase the risk of postoperative complications when compared with ssPNB[11] and large randomised controlled trials have indicated that this technique is safe for use in both inpatient and ambulatory settings, and in the paediatric population.[20-22] However, as with any technique, meticulous attention to safety is vital in order to mitigate the risk of complications.[23] Table I summarises significant complications of cPNB, which should be discussed with the patient during the pre-anaesthetic consultation.

Practicalities of cPNB

Types of catheters

Many types of perineural catheters (PNC) are available on the market and may be broadly defined as catheter-through-needle (CTN) or catheter-over-needle (CON) devices. When using CTN devices, care should be taken not to advance the catheter tip more than 5 cm beyond the needle, to avoid ectopic catheter placement and entanglement with sensitive structures.[23] Self-coiling catheters curl immediately upon exiting the needle, theoretically decreasing the catheter tip-to-nerve distance. CON devices have the advantage of greater ease of insertion, decreased catheter-site leakage and facilitating catheter-tip visualisation.[35]

Safety measures

While the risk of complications with cPNB is low, meticulous attention should be paid to safety measures. As with any regional anaesthesia, guidelines recommend standard patient monitoring during catheter placement, including electrocardiography, non-invasive blood pressure estimate and pulse oximetry.[36] Proper catheter tip placement should be confirmed by sonographic visualisation, the perineural infusion should be initiated in a monitored care environment such as the postoperative care unit and the patient should be monitored for at least 30 minutes after initiation.[23] Patients and staff should be educated on warning signs of cPNB-related complications and how to manage these. For both inpatient and ambulatory use, written instructions regarding catheter care and infusion management should be given to the patient along with contact details for the responsible anaesthesiologist in case of an emergency.

Ultrasound-guided insertion

As with ssPNB, ongoing evidence suggests widespread benefits of catheter insertion using ultrasound (US) guidance compared with electrical nerve stimulation, including higher success rate, less time required, less procedure-related discomfort and a lower risk of vascular penetration.[4] Presumably, US decreases the risk of inaccurate or difficult catheter placement and allows for confirmation of catheter tip placement.

Infection control measures

While clinically significant infections associated with cPNB are rare, insertion should be performed using a strictly sterile technique, as described in Table II.[36-38] After insertion, the catheter-site should be regularly observed for local signs of infection.

Table II: Recommendations on sterile procedures for insertion of perineural catheters

Recommendation	Comment
Remove all jewellery	
Wash hands with alcohol-based antiseptic	Required duration and formality of hand wash is currently unknown
Sterile gloves	Protects patients from cross contamination and HCP from occupational exposure
Sterile gowns	Currently insufficient evidence; however, advised in local guidelines for cPNB
Surgical facemask	Reduces likelihood of contamination of procedure site by pathogens from HCP's upper airway Protects HCP from occupational exposure
Chlorhexidine and alcohol skin preparation	Allow adequate time for drying
Sterile drapes	Isolate catheter insertion site
Sterile occlusive dressing over catheter	Ideally chlorhexidine-containing dressing
Bacterial filters	For long-term catheters
Clean US machine and probe with 70% isopropyl alcohol	
Sterile US probe cover	
Sterile US gel	

HCP – healthcare professional

Infusion regimens

The optimal protocol of local anaesthetic delivery for cPNB remains unclear.[2] Ropivacaine, bupivacaine and levobupivacaine provide similar analgesia. Prolonged infusion of ropivacaine 2 mg/ml exhibits an extraordinarily low incidence of LAST.[39] However, caution should be exercised when using prolonged infusions in elderly patients or those with comorbidities. While there is currently no evidence-based "ideal" delivery regimen, patient-controlled boluses do decrease local anaesthetic requirement and the use of automatic larger boluses with longer dosing intervals is gaining support.[40]

Post-insertion care

All patients should receive written instructions detailing catheter care, infusion protocol and warning signs of complications. Daily follow-up is mandatory to screen for signs of LAST, respiratory compromise (with proximal brachial plexus blocks), signs of infection, catheter displacement and inadequate analgesia. Follow-up may be in person or telephonic, depending upon local protocols.

Conclusion

cPNB can be extremely useful for managing various types of pain, including postoperative pain for surgical procedures associated with prolonged duration of significant pain. However, careful consideration should be given to patient and surgical factors, the expertise of the attending anaesthesiologist and systems available for follow-up after initiation of cPNB.

Conflict of interest

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